New Approaches to Scheduling Based on Fatigue Modeling

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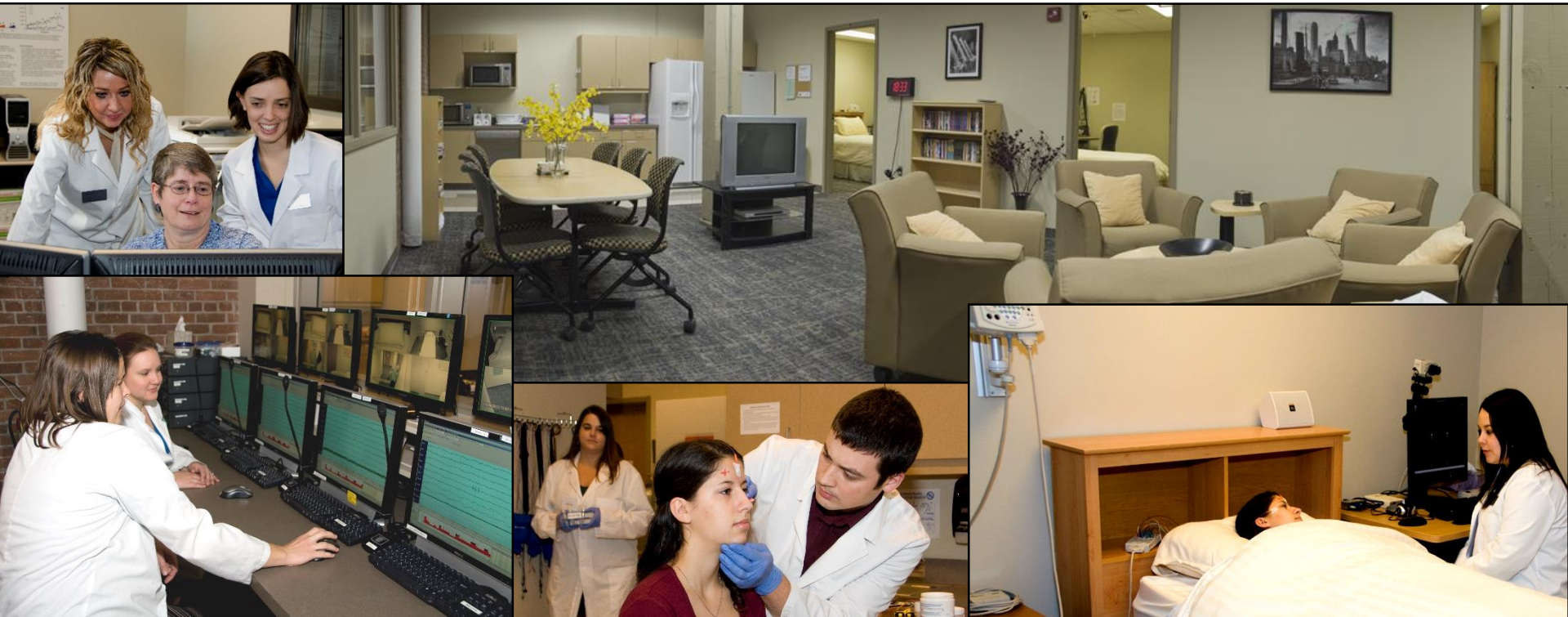
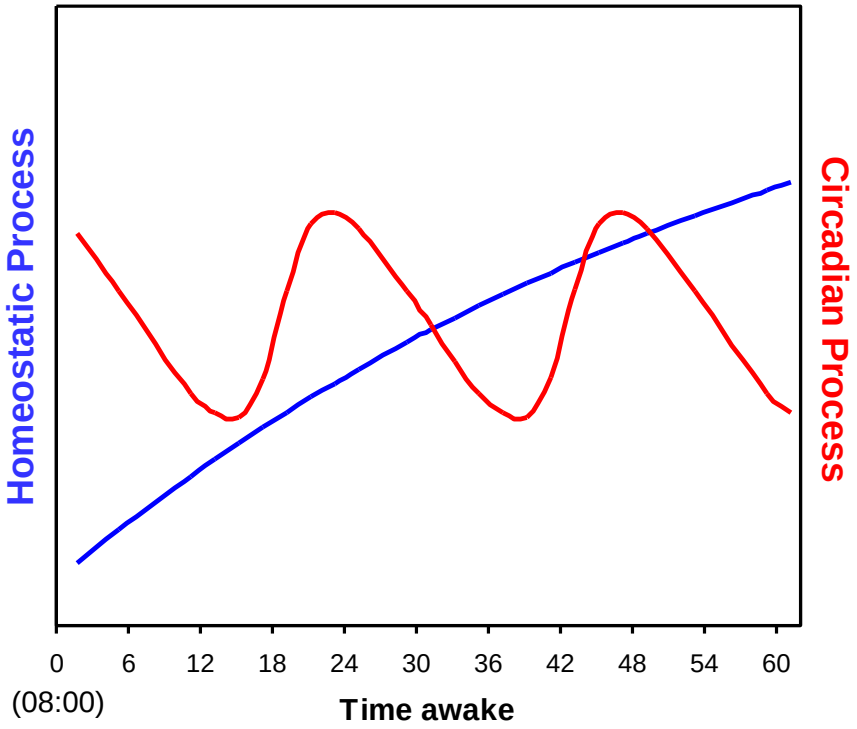
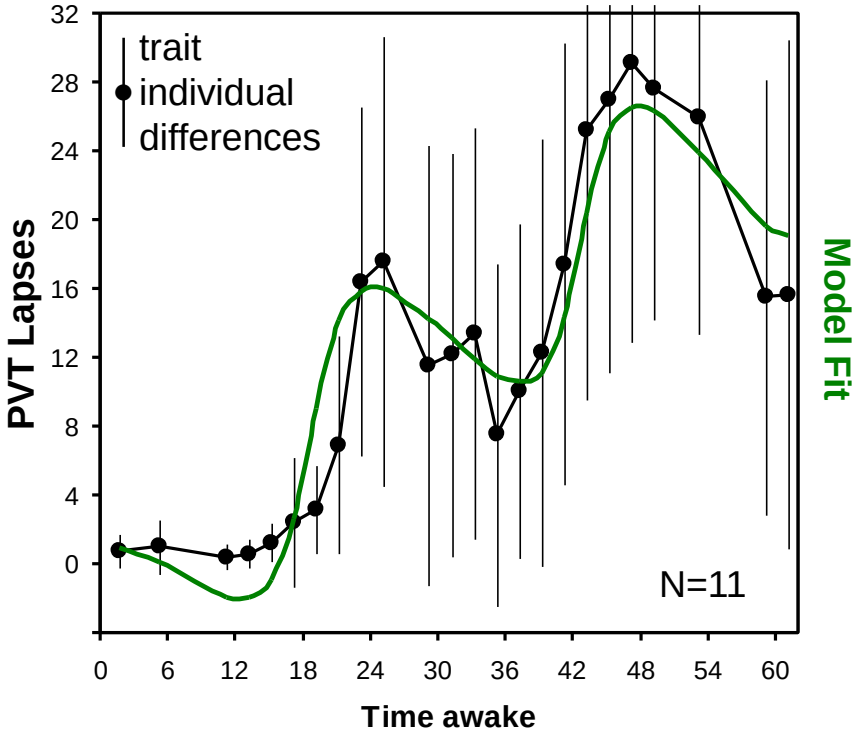


Homeostatic and Circadian Processes Drive Fatigue and Modulate Task Performance



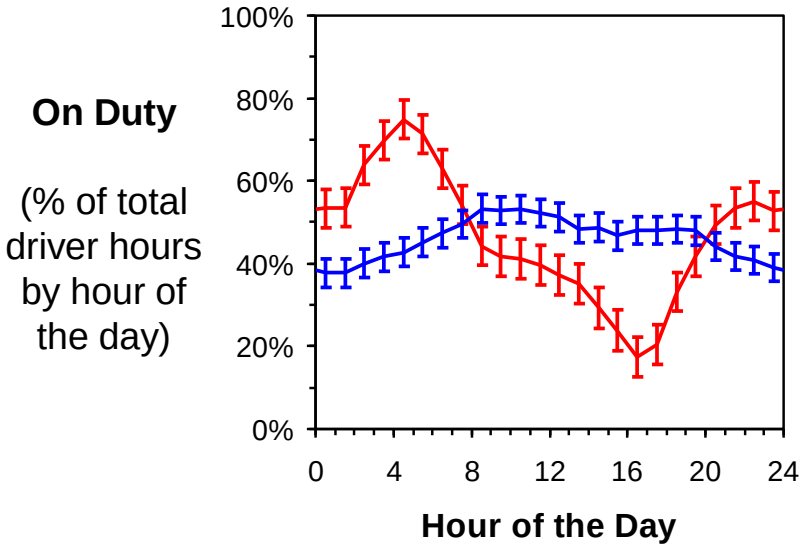


Borbély AA (1982). A two process model of sleep regulation. Hum Neurobiol 1: 195-204.

Van Dongen HPA, Belenky G (2009). Individual differences in vulnerability to sleep loss in the work environment. Ind Health 47: 518-526.

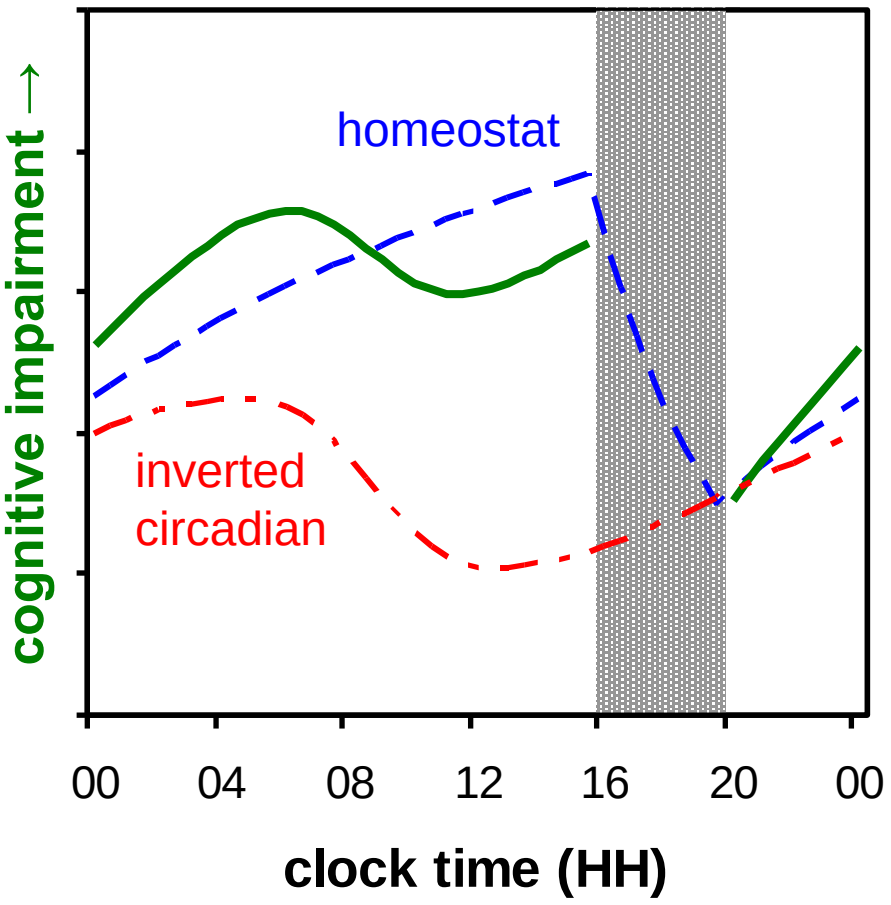
Psychomotor Vigilance Test (PVT)

Homeostatic and Circadian Processes Modulate Sleep Propensity during 24/7 Operations



Sparrow AR, Mollicone DJ, Kan K, Bartels R, Satterfield BC, Riedy SM, Unice A, Van Dongen HPA (2016). Naturalistic field study of the restart break in US commercial motor vehicle drivers: Truck driving, sleep, and fatigue. Accid Anal Prev 93: 55–64.

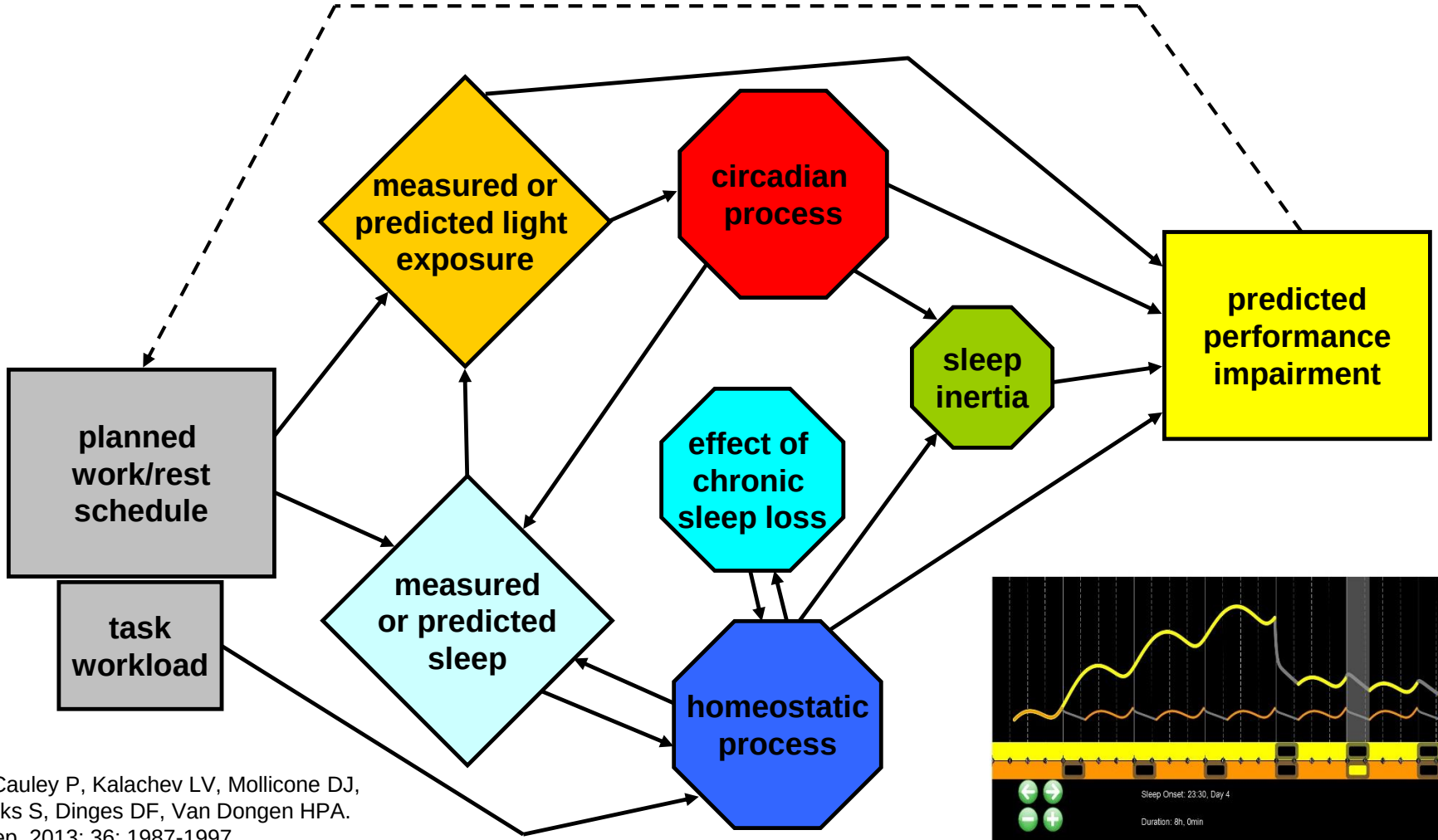
Neurobiological Challenge of Working Nights and Early Mornings



- The homeostatic drive for sleep builds up steadily over time awake
- At the same time, the circadian drive for wakefulness diminishes across the night and early morning
- Thus, the two effects amplify each other, and fatigue increases across the work period
- In addition, the circadian process restricts sleep duration during the early evening, making it difficult to get enough sleep each day

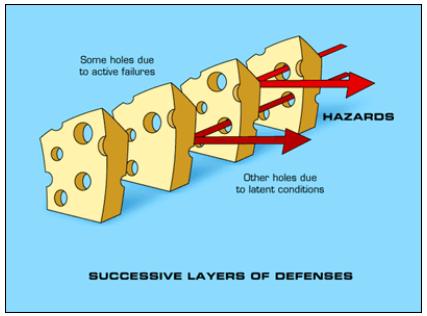
Van Dongen HPA, Jackson ML, Raj S.
MX Fatigue Focus 2010, 2(1): 7-9.

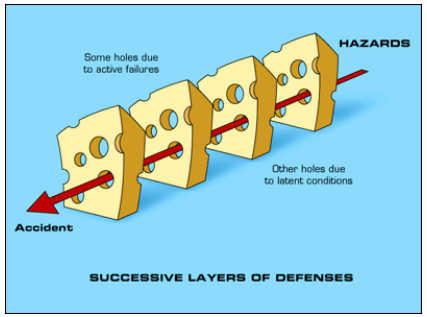
Mathematical Fatigue Models Predict Fatigue or Performance Impairment Based (Solely) on the Neurobiology of Sleep and Fatigue

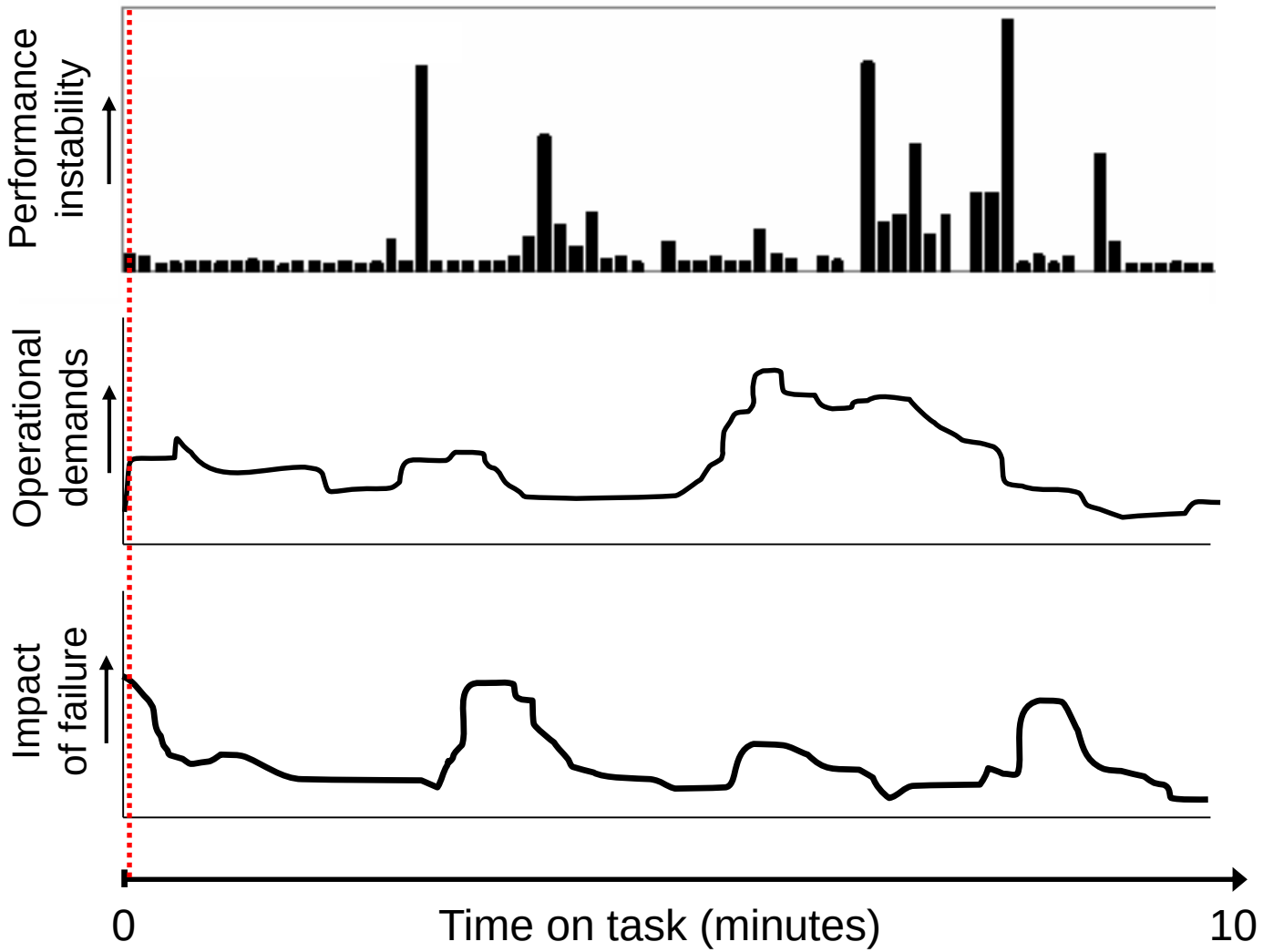


McCauley P, Kalachev LV, Mollicone DJ, Banks S, Dinges DF, Van Dongen HPA. Sleep, 2013; 36: 1987-1997.

The Association of Fatigue with Risk of Errors and Accidents Is Multi-Factorial

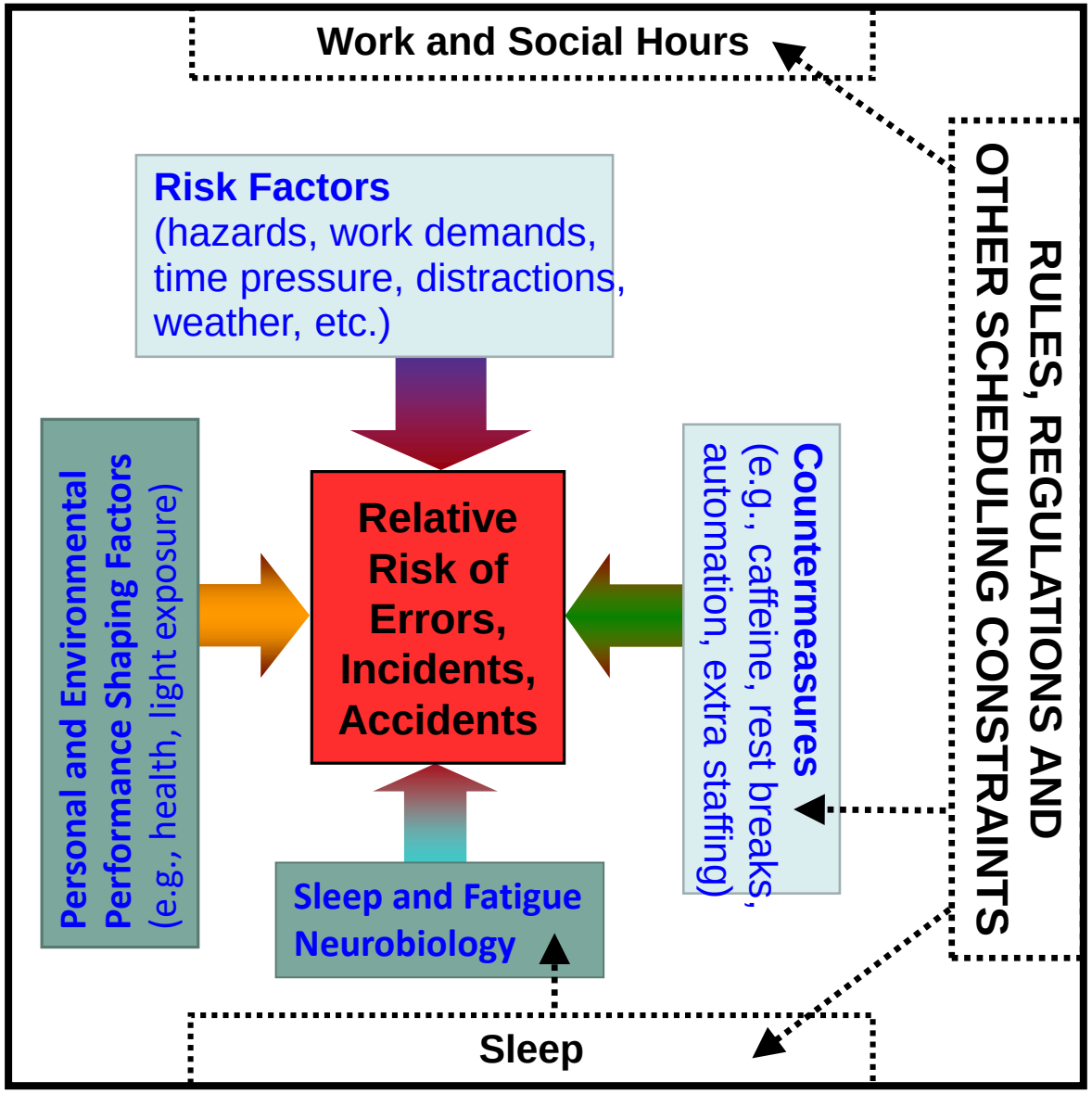






Van Dongen HPA, Balkin TJ, Hursh SR (2016). In Kryger MH, Roth T, Dement WC (Eds.), Principles and Practice of Sleep Medicine (6th ed.). Elsevier, pp. 682–688.

Toward a Relative Risk Framework to Address the Multi-Factorial Nature of Accident Risk



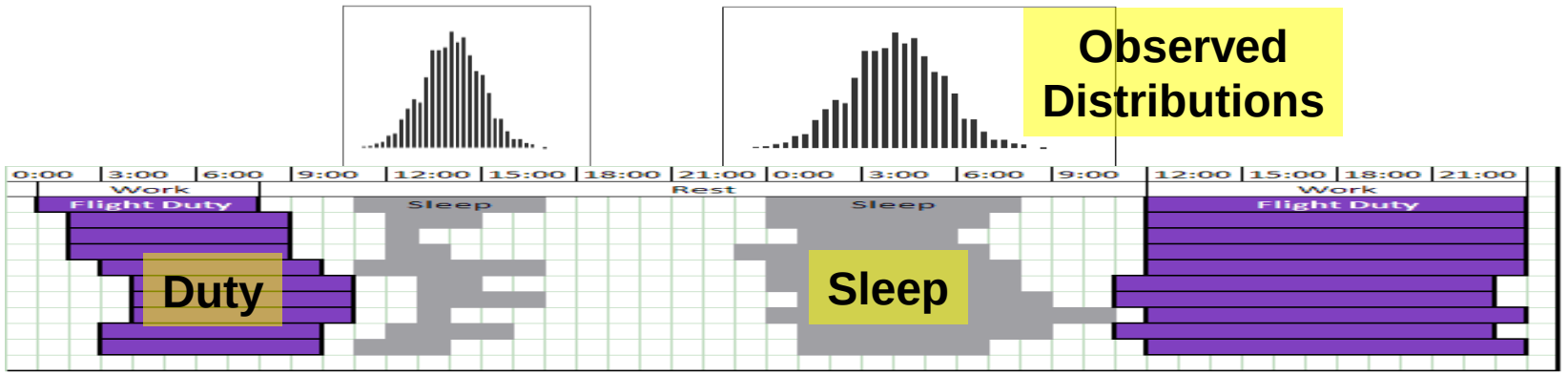
A common risk metric:

Signal-to-Noise Ratio

Chavali VP, Riedy SM, Van Dongen HPA (2017). Sleep, in press.

Jackson JE, Sanquist T, Campbell J, Lee EB, Van Dongen HPA (2013). Transp Res Rec 2347: 11-18.

Fatigue *Distribution* Modeling When Sleep Times Vary



Rangan S, Bowman JL, Hauser WJ, McDonald WW, Lewis RA, Van Dongen HPA (2013). Canadian Aeron Space J. 59: 1-6.

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